8.0-10271
CR-163343

(E80-10271) IMPROVEMENT OF THE EARTH'S GRAVITY FIELD FROM TERRESTRIAL AND SATELLITE DATA Status Report no. 16, 1 Jan. 1979 - 30 Jan. 1980 (Ohio State Univ., Columbus.) 5 p HC A02/MF A01 CSCL 08E G3/43

N80-29818

Unclas 00271

Improvement of the
Earth's Gravity Field from Terrestrial
and Satellite Data

Status Report (XVI)

Period Covered: January 1, 1979-June 30, 1980

Research Grant No. NGR36-008-161

OSURF Project No. 783210

Prepared for:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

The Ohio State University
Research Foundation
Columbus, Ohio 43212

July, 1980

1. Introduction

The work being performed under this grant is directed towards the improvement of our knowledge of the gravity field of the earth and in the analysis of quantities that depend on the gravity field.

2. Work Accomplished

Under this grant research has been conducted in several different topic areas. This research has been carried out by Graduate Research Associates and the Principal Investigator. We now describe the activities that have taken place during this reporting period.

2.1 Terrestrial Anomaly Field Improvement

We have continued during this period to update our $1^\circ \times 1^\circ$ terrestrial mean anomaly tape. The version developed during this reporting period is called the October 79 version. This was an update of a June 78 data tape. The new tape contains 41973 anomalies based on data from 45 data sources. Of these anomalies 721 values had standard deviations greater than 30 mgals and 16209 values were based on data sources exclusive of the Defense Mapping Agency Aerospace Center. In addition we identified 6912 anomalies that may have been predicted through geophysical correlation techniques. Additional details may be found in Rapp (1980a).

From this data we have also prepared two global sets of 1654 5° equal area anomalies. The first set was based on all $1^\circ \times 1^\circ$ data excluding anomalies whose standard deviations were greater than 30 mgals. The second set was similar to the above but deleted the geophysically predicted anomalies.

The $1^\circ \times 1^\circ$ and 5° anomaly sets were sent to Frank Lerch on January 9, 1980. We also sent the combined terrestrial/altimeter data file containing a merger of the October 79 tape with the anomalies devised from the Geos-3 altimeter data.

We have also prepared a document that explains our updating procedures and the computer programs involved. The document is entitled: Programs and Procedures for Updating the OSU $1^\circ \times 1^\circ$ Gravity Anomaly Tapes. A copy of this report was sent to Frank Lerch on March 5, 1980.

Currently we are evaluating several new data sources. We tried at the IUGG/IAG meeting in Canbera to establish some data exchange with some Chinese colleagues but to this point nothing specific has happened.

2.2 Improved Geoid Determinations

Research was also carried out in seeking better analytical techniques

for geoid undulation computations. The procedure to be improved upon is the case where potential coefficients and surface gravity anomaly information are combined to determine detailed geoid information.

The results of this research have been quite successful and are documented in three places (Rapp, 1979, 1980b) and Jekeli (1980). The abstract of the Jekeli report is as follows:

The truncation theory as it pertains to the calculation of geoid undulations based on Stokes' integral, but from limited gravity data, is reexamined. Specifically, the improved procedures of Molodenskii et al. (1962) are shown through numerical investigations to yield substantially smaller errors than the conventional method that is often applied in practice. In this improved method, as well as in a simpler alternative (Meissl, 1971b) to the conventional approach, the Stokes' kernel is suitably modified in order to accelerate the rate of convergence of the error series. These modified methods, however, effect a reduction in the error only if a set of low-degree potential harmonic coefficients is utilized in the computation. Consider, for example, the situation in which gravity anomalies are given in a cap of radius 10^{o} and the GEM 9 (20,20) potential field is used. Then typically, the error in the computed undulation (aside from the spherical approximation and errors in the gravity anomaly data) according to the conventional truncation theory is 1.09 m; with Meissl's modification it reduces to 0.41 m, while Molodenskii's improved method gives 0.46 m. A further alteration of Molodenskii's method is developed and yields an RMS error of 0.33 m. These values reflect the effect of the truncation, as well as the errors in the GEM 9 harmonic coefficients. The considerable improvement, suggested by these results, of the modified methods over the conventional procedure is verified with actual gravity anomaly data in two oceanic regions, where the GEOS-3 altimeter geoid serves as the basis for comparison. The optimal method of truncation, investigated by Colombo (1977), is extremely ill-conditioned. It is shown that with no corresponding regularization, this procedure is inapplicable.

2.3 GRAVSAT Analysis

Although not a formal part of our grant effort, some research was carried out in an error analysis approach to considering the accuracy of the determination of mean anomalies and mean undulations from a GRAVSAT mission. The analysis carried out was based on considering error propagation errors, and truncation errors. We now have a theory and an operating program to handle many different mission parameters. Some results are described in Rapp (1980a). A detailed report by Jekeli and Rapp is now being prepared.

3. Future Work

We will continue our $1^\circ \times 1^\circ$ data collection work. More intensive work is needed to identify bad $1^\circ \times 1^\circ$ anomalies. For our next update we may have additional Geos-3 and Seasat data that may be used to verify ground based data.

We will continue to work with our improved geoid computation procedures with specific attention being given to using high degree reference fields such as GEM10B. The problem here is to obtain a realistic accuracy assessment of the potential coefficients.

4. Personnel

During this reporting period the following persons have participated in the work of this grant:

Richard H. Rapp, Project Supervisor
Thomas Croxell, Graduate Research Associate
Christopher Jekeli, Graduate Research Associate
Kostas Katsambalos, Graduate Research Associate
Agit Singh, Graduate Research Associate
Kamil Eren, Graduate Research Associate
Pamela Pozderac, Secretary

5. Reports and Papers

We give here reports and papers that have been produced under this grant since the last status report.

Christodoulidis, D., Accuracy of Relative Oceanic Geoid Computations, J. Geophy. Res., 84, Sept. 10, 1979.

Christodoulidis, D., Influence of the Atmosphere Masses on the Gravitational Masses of the Earth, Bulletin Geodesique, Vol. 53, No. 1, 1979.

Jekeli, C., Accuracy Estimates of Geoid Undulation Differences, Computed from Gravity Disturbances, Anomalies and Potential Coefficients, paper presented at the 1979 Spring Meeting of the American Geophysical Union, Washington, D.C., May 1979.

Jekeli, C., Global Accuracy Estimates of Point and Mean Undulation Differences Obtained from Gravity Disturbances, Gravity Anomalies and Potential Coefficients, Department of Geodetic Science Report No. 288, May 1979.

- - - - Programs and Procedures for Updating the OSU $1^\circ \times 1^\circ$ Gravity Anomaly Tapes, internal report, Department of Geodetic Science, The Ohio State University, February, 1980.

Katsambalos, K., The Effect of the Smoothing Operator on Potential Coefficient Determinations, Department of Geodetic Science, Report No. 287, March 1979.

Rapp, R. H., The Oceanic Geoid, paper presented at the XVII General Assembly, IUGG,IAG, Canbera, Australia, 1979.

Rapp, R. H., The $1^{\circ} \times 1^{\circ}$ Mean Anomaly Field of the Earth and Prospects for Its Improvement, paper presented at the 4th International Symposium, Geodesy and Physics of the Earth, Karl-Marx-Stadt, GDR, May 1980.

Rapp, R. H., A Comparison of Altimeter and Gravimetric Geoids in the Tonga Trench and Indian Ocean Areas, Bulletin Geodesique, Vol. 54, 1980b.